What is MBSE?

Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.

3 Pillars of MBSE applied in E-ELT project:

**Language:** SysML

**Method:** State Analysis and OOSEM

**Tool:** MagicDraw

MBSE and SysML were chosen to model the Telescope Control System (TCS), which controls:

- 10,000 tons of steel and glass
- 20,000 actuators, 1,006 mirrors
- 60,000 I/O points, 700Gbps/s, 17Gb/s

**Challenge:** The position of segments consisting 1000 mirrors must be coordinated to deliver a continuous surface with an error below 100nm.

**Major MBSE usage aspects:**

- Model organization
- Reusability
- Model Documentation
- Configuration and Collaboration
- Requirements Specification
- Different perspectives of the system:
  - System Structure
  - Multiple Internal Structures
  - Behavior Model
  - Data Model
- Analysis:
  - Verification and Validation
  - Variant Modeling and Trade-off Analysis

**Results:**

- Preliminary design is delivered
- Proved that SysML effectively supports SE and handles the complexity
- Became one of the most influential project for standard and tool development:
  - Input for SysML REF
  - Feedback for tool vendor (400+ official requests)
- Cookbook for MBSE with SysML with guidelines was created
- In 2010, INCOSE presented an award to the Telescope Modeling Challenge Team for Achieving the Systems Engineering Vision 2020
- Inflected impact on other telescope projects

Other Telescope Projects Using MBSE

**European Extremely Large Telescope (E-ELT)**

- Budget: €1,055M
- Main mirror: 40m diameter
- Height: 80m
- Footprint: 100m